THURSDAY, JULY 28, 1910.

PLANETOLOGY.

The Evolution of Worlds. By Prof. Percival Lowell. Pp. xiii+262. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1909.) Price 10*s.* 6*d.* net.

ONLY by the minutest study of that which is can finite man of a finite epoch hope to draw even the roughest sketch of the antecedent, or form the vaguest speculations as to the ultimate; the truth of the sketch and the soundness of the speculation increase or decrease in proportion to the knowledge acquired by the observer. Therefore we welcome a volume in which Prof. Lowell sets out a scheme of evolution which embodies a proper sequence of congruities and is based on the results of years of careful observation.

Planetology is defined as the astronomy

"which deals with the evolution of worlds. It treats of what is general and cosmic in that evolution, as geology treats of what is terrestrial and specific in the history of one member of the class, our own earth."

On these lines Prof. Lowell develops a scheme of evolution wherein the observational evidence wrested from what is, leads to the speculations as to what was and what will be.

The matter originally formed the subject of a university course of lectures, but a larger public demanded it, and hence the present volume.

There are seven chapters in which the probable life-histories of a planet and of a planetary system are vividly portrayed, and a perusal of the first, "The Birth of a Solar System," impresses very forcibly the idea how finite is man, how infinite matter and time. The inception of a new system is but the death-knell of its predecessor.

The problem of the birth was solved when Goodricke, the deaf mute of York, divined the cause of Algol's demoniacal winkings—a dark sun; on this is based the whole story. The descriptions of a number of Novæ support the statement that cataclysms are not unknown, and, by several lines of reasoning, the production of spiral nebulæ—the matrices of new worlds—is shown to be the result. The planetesimal hypothesis is probably now too well known to call for further elaboration here of Prof. Lowell's story of the birth, but before proceeding to the second chapter he draws a wonderfully awful picture of the conditions which would precede and attend the incursion of a second dark body, which, by its powerful perturbative action, would once more produce chaos from our present orderly system.

In the second chapter we are given descriptions of the existing proofs of this cataclysmic birth. The existence of myriads of meteors in interplanetary space, their common motions, and their likeness to terrestrial material, are cited as evidence of a common origin in one rotating mass. The mathematics for this—mathematics being "a precise reasoning applic usually to the discovery that a pet theory will not work," but more fruitful in this instance—are, with other more or less profound items, relegated to a series of notes at the end of the book. The physical evidence for this common origin reaches a climax with a statement of the varying densities of the planets; those torn off earlier by the tidal stress are less dense because they formed the upper layers of the parent dark body. Thus the hydrogen envelopes of Neptune and Uranus, demonstrated by Dr. Slipher's spectrograms, are evidences of primogeniture.

In the chapter on inner planets, many old "facts" are reorganised, on the evidence of the careful observations made at Flagstaff, and, as they have not yet appeared in their new forms in the ordinary text-books, their statement here is a useful addition to astronomical literature. Among others, the correction to the diameter of Mercury, so dramatically confirmed, independently, by Newcomb, is an example of the value of such careful attention to observing conditions and observations as has been paid at Flagstaff. Students of astronomy will also experience a feeling of relief that the rotation periods of Mercury and Venus now appear to be placed beyond question. The following description of Mercury is so characteristic of Prof. Lowell's graphic style as to be worth quoting:—

"Two antipodal hemispheres divide the planet, the one of which frizzles under eternal sun, the other freezes amid everlasting night."

The persistent observations at Flagstaff also dispelled the idea of a cloud-covered Venus, replacing it by a diaphanously-clad body on which the strong winds sweep up enough dust to account for the planet's high albedo. The radial streaks depicted on the accompanying drawing of the planet are supposed to be "runs" produced by winds which have consistent, and persistent, directions. An interesting suggestion is that the "earth-light" sometimes seen on Venus's dark limb is but a darkened vision of the ice which for countless æons has been hoarded up on that side of the planet which never sees the sun. "Monotony eternalised" is Prof. Lowell's apt description of the Mother of Loves.

It is with something like a shock that the reader finds but about a page and a half devoted to Mars; but the author opines that he has already treated adequately of the subject elsewhere. Phobos and Deimos are dealt with, however, and, according to Prof. Lowell's observations, they are larger than hitherto supposed; he gives 36 miles and 10 miles as their probable, respective, diameters. The dilatation of "Fear" and "Panic" by observations made at the Flagstaff Observatory may not appear to some conservative tenants of "facts" as a novelty.

Coming to the minor planets, evidence is cited to show that Olbers's theory of an exploded planet is untenable, and that this congeries of fragments represents what would have been a planet had not the giant Jove prevented the agglomeration. By plotting the major axes of their orbits in the form of a spectrum band, the wave-lengths scale being replaced by one of astronomical units, Prof. Lowell shows how commensurability of period with the period of Jupiter has determined the location of the asteroids. The

variability of magnitude exhibited by minor planets is accepted as evidence of dissymmetry, and this, in turn, is taken as evidence for the initial cataclysm as described. Torn by tidal stress, the dark sun was disrupted while still solid, the dissymmetry showing that the asteroids have never been in a fluid state.

Jupiter as a semi-sun is discussed at some length, its albedo of 0·75, as compared with Muller's 0·72 for clouds, being ascribed as possibly due to intrinsic light; the same explanation is offered for Saturn's albedo of 0·78. Jupiter's independence of the sun—its belts of cloud are apparently not affected by the rotation or revolution of the planet—serves as an illustration of the earlier condition of the earth, and other planets, before the advent of the sun-sustained period.

Of Saturn and Uranus but little is related, but the story of Neptune's discovery is told at some length. Rather more stress than usual is laid on Prof. Pierce's demonstration that Galle's discovery was a lucky accident. The problem solved by Leverrier and Adams was capable of three solutions, and it was but by chance that they attacked the right one.

"Congruities" is the keynote for the chapter on the formation of planets, and Prof. Lowell urges that incongruities, discovered since Laplace's time, have killed the nebular hypothesis. He then marshals the mutually-sustaining facts in support of the planetesimal hypothesis. By curves showing the masses of the planets relative to their solar distance, and others demonstrating the analogies of satellites and primaries in their departures from the common plane, he shows that the congruities, on this hypothesis, are perfect—to-day; future discoveries may necessitate further steps.

Having thus brought us to the formation of planets as discrete bodies, the author proceeds to outline the probable history of the finished sphere. On the one hand, we have the physical development, the cracks and cataclysms which formed our geographical features along lines necessarily different from those obtaining on Mars, or any other world; on the other is the chemical development, "as universal as the universe itself." Evidence that darkness was spread over the face of the earth is gleaned from many quarters, all showing that our planet was a sunless forcing-house; this was the self-sustained age. Then the earth cooled, the dense cloud covering condensed, admitting sunlight, and we arrived at the sun-sustained epoch which we still enjoy. Here the story of evolution is exceedingly interesting, especially that dealing with the Ice age. Probably the statements will be criticised by some geologists, but the author's substitute for what he terms their "astrocomico" suggestions is none the less attractively stated. The extraordinary ellipticity of the orbit, to account for the Glacial epoch, is rejected, and is replaced by one in which excessive evaporation and precipitation, producing polar ice-sheets of great thickness, play a great part. It is also shown that the glaciation was restricted to well-marked raised areas, such as Norway, Scotland, Labrador, Keewatin, &c., and was nothing more than a natural terrestrial phenomenon; observations of Mars show that, at the present time, the polar highlands retain their covering of snow for some time after the general melting of the cap has separated them from the main body of it.

In the last chapter the "Death of a World" is discussed, and the possible modes of extinction examined. It may be by collision with a dark sun, but, failing that, it is inevitable by the action of tidal friction and the diffusion of water and atmosphere. Collating the facts gleaned from the previous study of the several planets, it is shown that there is a more or less orderly sequence culminating in the present condition of our own satellite. *Sans* season, *sans* day and night, *sans* water and *sans* atmosphere, the worlds will await the quickening which can only come by the advent of a cataclysm such as is described in the earliest chapters.

The printing and illustration of the volume are beyond criticism, although the paper is rather heavy, and with its graphic language, its sustained interest, and clear story, the book is sure to appeal to the general reader who would learn more of the past, and of the probable future, of our earth and its fraternity.

WILLIAM E. ROLSTON.

NATURE-STUDY.

(1) *The Nature-Study Idea. An Interpretation of the New School-movement to put the Young into Relation and Sympathy with Nature.* By L. H. Bailey. Third edition, revised. Pp. ix+246. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1909.) Price 4*s.* 6*d.* net.

(2) *Man and Nature on Tidal Waters.* By Arthur H. Patterson. Pp. xvi+315. (London: Methuen and Co., 1909.) Price 6*s.*

(3) *Tommy's Adventures in Natureland. A Nature Story for Boys and Girls.* By Sir Digby Pigott, C.B. Pp. xvi+180. (London: Witherby and Co., 1909.) Price 2*s.* 6*d.* net.

(4) *Animal Romances.* By Graham Renshaw. Pp. vi+206. (London: Sherratt and Hughes, 1908.) Price 7*s.* 6*d.*

(1) PROF. L. H. BAILEY is well known as a botanist who believes in the practical and educational value of his science, and he has shown himself on many occasions able to give good reasons for the faith that is in him. In the present volume he discusses, in a lively and unconventional fashion, the true inwardness of "nature-study," which is not science, nor knowledge nor facts. "It is spirit. It is an attitude of mind. It concerns itself with the child's outlook on the world." "It would be better if it were called nature-sympathy." We do not think that professional educationists will quite agree with Prof. Bailey in associating all the pædagogical virtues with nature-study (for many of them may be expressed in the study of history, for instance), but most who have any sympathy at all with studying the world around us will agree with the sound educational sense which the book expresses. In a breezy and interesting fashion he discusses how nature-study may be taught, the school-garden, the rural-school problem, the teacher's outlook on nature, and about half a